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Partial Conversion of Poor Hardwood Stands to Conifers by Planting

LEON S. MINCKLER
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Hardwood timber on poor upland sites in the Central States is commonly low in quality and yield. Natural shortleaf pine in Missouri and in the southern part of the Central States region generally produces more and better timber on dry, narrow ridgetops and upper south slopes with shallow soil than do hardwoods.^{1/} Redcedar also grows well on such sites. So converting from pure hardwoods to a mixture of hardwoods and pine or cedar by planting is one promising way of increasing the production on these poor sites. Recent tests at the Kaskaskia Experimental Forest in southern Illinois show that successfully converting poor hardwood stands to mixed hardwood-conifers by planting depends chiefly on the size of openings planted, the quality of the site, and the amount, timing, frequency, and effectiveness of release done after the conifers are established.

^{1/} Liming, Franklin G. Response of planted shortleaf pine to overhead release. Cent. States Forest Expt. Sta., Tech. Paper 105, 20 pp., illus. 1946.

Shortleaf pine and eastern redcedar were planted (1) under the canopy of poor hardwood stands, (2) in openings ranging from 15 to 120 feet in diameter, and (3) on a 17-acre recently clear-cut area. In some stands the openings were deliberately cut to specified diameters (30, 60, and 120 feet) to correspond to half, once, and twice the height of the trees. In another stand the openings were of various sizes left after the stand had been partially cut. Trees were planted at a 6 x 6 spacing except on the clear-cut area where spacing was 7 x 7 feet. All told, about 4,000 trees were planted under the canopy in 24 different places, about 4,000 were planted in 88 openings, and 15,000 were planted on the 17-acre, clear-cut area. Old-field plantings of pine in the vicinity, established at the same time, were also available for comparison. During the first 8 years after planting, all the trees planted on the clear-cut area and cut openings were released once or twice by cutting competing hardwood brush with an ax.

WHAT HAPPENED

Trees grew faster the larger the openings and the less competition from hardwoods (fig. 1). At 8 years of age, pine plantations in nearby open fields were about 4 times taller, and pine in the clear-cut area 3 times taller, than pine in the 30-foot openings (fig. 2). The redcedars in all openings averaged about 1 foot shorter than pine but their relative response to reduced competition was similar. However, the cedar trees growing in reduced light had better form and appeared more vigorous than the pine (fig. 3).

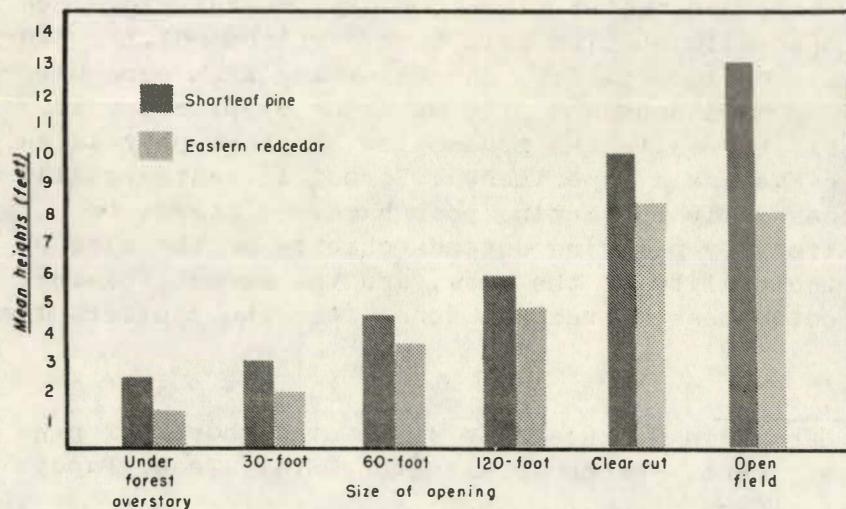


Figure 1.--
Mean heights of
shortleaf pine
and eastern red-
cedar 8 years
after planting
in various-sized
openings.



Figure 2.--(A) Shortleaf pine under canopy, 8 years after planting;
(B) Shortleaf pine in 30-foot opening, 8 years after planting;
(C) Shortleaf pine in 60-foot opening, 8 years after planting.
This is one of the more vigorous trees.
(D) Shortleaf pine in 120-foot opening, 8 years after planting.

In openings cut to specified sizes, survival of pine and cedar after 8 years was adequate (table 1). In the 60- and 120-foot openings, planted trees survived at the rate of about 600 per acre. Most mortality was caused by suppression from hardwood brush. In addition, defoliation by pine sawfly killed or helped kill pine trees in some plots.

Table 1.--Survival^{1/} 8 years after planting
as related to opening cut to specified size

Diameter of opening (in feet)	Survival (in percent)	
	Shortleaf pine	Eastern redcedar
30-foot opening	75	41
60-foot opening	42	52
120-foot opening	55	46
Under forest overstory	48	30

^{1/} Means of 4 plots.

Figure 3.--(A) Redcedar in 30-foot opening, 8 years after planting.
(B) Redcedar in 60-foot opening, 8 years after planting.



The trees planted in the openings of the partially cut stand showed heavy mortality and relatively poor growth after 7 years (table 2). Openings less than 60 feet in diameter contained about 5 trees, averaging only about 4 feet in height. The openings larger than 60 feet in diameter contained many more trees but of the same height. In these openings cedar was as tall as the pine. These trees were released once from hardwood competition 3 years after planting; another release was needed in 1957. The openings in the canopy were clearly much too small for the pine. Here the cedar had good form and vigor, but it, like the pine, will require repeated release and enlarging of the overstory openings for continued good growth.

Mortality of planted trees caused by competition from hardwoods on the 17-acre clear-cut area during the 8 years was heavy (table 3). The 900 trees per acre planted in 1949 were reduced to about 800 the first year, but by 1955 the number had dropped to 380. Of these only 110 were dominant and it was clear that a release was needed. The release was made and it slowed the rate of mortality. By 1957 there remained 90 dominant planted trees (fig. 4), and an additional 140 trees were free from overhead shade but had close side competition. The rest of the pine and cedar were overtapped. By this time it became evident that another release was needed and it was made in June 1957.

Figure 4.--
Shortleaf pine
in clear-cut
area, 8 years
after planting.
The trees shown
are dominant
and free from
overhead or
close side
competition.



Table 2.--Success^{1/} of shortleaf pine and eastern redcedar
7 years after planting in openings cut in forest overstory

Diameter : of opening: (in feet):	Shortleaf pine Openings : Live trees: Mean : per opening:height	Eastern redcedar Openings : Live trees: Mean : per opening: height				
	Number	Number	Feet	Number	Number	Feet
0-29	19	2.9	3.0	4	2.0	4.0
30-59	28	4.8	3.6	4	4.0	4.1
60 plus	7	17.3	4.3	2	8.5	4.0

^{1/} About 1,900 trees were planted in the openings on 14 acres in 1950. After 7 years there are about 350 live trees remaining. The actual number per acre in the openings cannot be accurately given, but 5 trees in a 50-foot opening or 17 trees in a 100-foot opening would be at the rate of about 100 trees per acre.

Table 3.--Success of shortleaf pine and eastern redcedar
8 years after planting on a 17-acre clear-cut area

Crown competition	Number of trees		Mean height	
	per acre ^{1/}		(in feet)	
	Shortleaf : pine	Eastern : redcedar	Shortleaf : pine	Eastern : redcedar
None	77	13	11.4	9.5
Side only	135	6	8.5	7.3
Overtopped	58	45	6.8	2.9
Total	270	64	8.9	6.5

^{1/} 900 trees per acre planted in 1949; about 750 shortleaf pine and 150 redcedar.

On the clear-cut area there were 270 shortleaf pine and 64 redcedar per acre after 8 years. A higher percentage of cedar than pine was overtopped. Dominant pine averaged 2 feet taller than dominant cedar. For intermediate trees, pine was only 1 foot taller. The overtopped cedar was less than half as tall as the overtopped pine but the cedar crowns had better form and denser foliage.

Site quality had an important effect on the success of stand conversion attempts. Generally, the better the site the faster hardwoods grow in comparison with pine and cedar, and the more difficult and costly conversion becomes. On the better sites of the clear-cut area planted in this study, virtually all the pine was overtopped and killed by the fast-growing hardwoods. So it is important that any conversion to conifers in southern Illinois or similar areas be confined only to the poorest ridges and upper slopes where hardwoods grow very slowly and have inferior quality.

WHAT WE LEARNED

For the areas studied it is clear that the success of conversion plantings of shortleaf pine or redcedar depends upon (1) the size of the overstory opening and (2) the severity of competition from hardwood sprouts and saplings. A completely clear-cut area is best (fig. 5) but pine and cedar will succeed moderately well if the diameter of the opening is large enough. Where plantings in openings are made, however, the openings must usually be enlarged as the conifers grow larger.

To convert low-quality hardwood stands having no good growing stock trees to stands of conifers, it is evident from this study that all hardwood competition on the area be killed before planting. When plantings are made for partial conversion, the good growing stock trees should be left, of course, and all others cut or killed. A deliberate attempt should be made to create openings 1 1/2 to 2 times the height of the overstory trees and no openings smaller than this should be planted.

The important lesson learned about releasing conifers from hardwood brush (mostly oak and hickory) is that the kill must include both the tops and the roots, and that release must be soon enough and frequent enough to allow continued vigorous growth of the planted trees. On the clear-cut area the conifers were not released from competition until 6 years after planting. This was almost too late and the release was effective for only a short time



Figure 5.--The clear-cut area at the time planting was done.

because hardwood stems were merely cut with an ax. In 2 years the sprouts were as tall or taller than when cut. Ax cutting of competition was not an effective release treatment. It is recommended that control of hardwoods in conversion plantings be done by poisoning.

(The herbicide 2,4,5-T may be effectively used. Basal spraying or frilling of stems permits a selective kill, allows the release of crop trees, and permits the leaving of superior hardwood stems to help form a mixed conifer-hardwood stand where desired. Spraying hardwood foliage by air has met with some success^{2/} and

^{2/} McConkey, Thomas W. Helicopter spraying with 2,4,5-T to release young white pine. Northeast. Forest Expt. Sta., Sta. Paper No. 101, 14 pp., illus. 1958.

could be used on large planted areas where a complete conversion to conifers was desired.^{3/} However, foliage sprays normally kill the top and not the roots, and sprouting may occur.^{4/})

The timing and intensity of release are also important. When the intent is to fully convert to conifers, an attempt should be made to kill all the hardwoods before planting. If a mixed hardwood-conifer stand is desired, selective poisoning should be done and future release may be on a crop-tree basis. In this case the diameter of the released area (around the tree) should be at least twice the height of the competing hardwood stems being killed. Observations on the clear-cut area studied here indicate that conifers should be released when the competing hardwoods begin to shade the upper half of the crowns of the crop trees.

Conversion of native hardwood stands to conifers or mixed conifer-hardwoods by planting will probably not be permanent. After one rotation of pine the native hardwoods will probably re-establish themselves unless steps are taken to retain the conifers in the stands. More likely, replanting accompanied by release will be required. Here, a costs-and-returns analysis is needed to determine whether these practices are profitable. Generally, in the Central Hardwood region, where conifers are not native, conversion planting should be confined only to the poorest sites.

^{3/} Rogers, Nelson F. Airplane-sprayed herbicides release shortleaf pine from hardwoods. Cent. States Forest Expt. Sta., Sta. Note 117, 2 pp. 1958.

^{4/} Nichols, J. M. Control of woody vegetation. Mo. Univ. Agr. Expt. Sta. Res. Bul. 638, 26 pp. 1957.

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